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## Design of a simulation of multiple perspectives in road safety education

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# **Design of a Simulation of Multiple Perspectives in Road Safety Education**

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## **Abstract:**

The possibilities afforded by new multimedia technology, combined with contemporary ideas about learning, have opened up new design opportunities for educational simulations. In particular, the use of sophisticated multimedia environments have made the design of experiential simulations, in which the learner plays an authentic role carrying out complex tasks, a much more tractable design task. This paper describes the use of an educational simulation paradigm to represent multiple perspectives in a road safety context and the evaluative strategies that were undertaken to ensure the teaching resource will lead learners to a stronger understanding of the various factors that interact and contribute to the potential harm in road safety contexts. We also suggest that students will be more able to identify these factors in their own personal contexts and make decisions about modifying their behaviour to decrease any potential harm.

## **Introduction**

The possibilities afforded by new multimedia technology, combined with contemporary ideas about learning, have opened up new design opportunities for educational simulations. In particular, the use of sophisticated multimedia environments has made the design of experiential simulations, in which the learner plays an authentic role carrying out complex tasks, a much more tractable design task. This contrasts with an earlier emphasis on the design of simulations, which allowed learners to explore the behaviour of systems in symbolic terms - so called *symbolic* simulations.

Given the complex interplay of many factors in crash causation (human, vehicle and environmental), the use of an educational simulation paradigm to represent multiple perspectives in a road safety context is ideally placed. We propose that the experiences gained in the implementation of these simulations will lead learners to a stronger understanding of the various factors that interact and contribute to the potential harm in road safety contexts. The simulations were also designed so that students will be able to identify these factors in

their own personal contexts and make decisions about modifying their behaviour to decrease any potential harm. By providing an environment where students are able to view a context from a variety of viewpoints (passenger, pedestrian, wheels user or future driver) they may also develop an understanding and empathy for the different roles of the players within a road safety context.

### Contemporary Theories of Learning

Many writers have stressed the need for open-ended, exploratory, authentic, learning environments in which learners can develop personally meaningful and transferable knowledge and understanding. The lead provided by these writers has resulted in the proposing of guidelines and criteria for the development of software based on a constructivist view of learning (e.g., Duffy & Cunningham, 1996; Grabinger, 1996; Grabinger, Dunlap & Duffield, 1997; Hannafin & Land, 1997; Savery & Duffy 1995; Squires, 1996).

Harper, Squires, and McDougall (2000) indicate that a recurrent theme of these guidelines is that learning should be *authentic*. They have noted that a review of the literature points to three seminal concepts, which originate from the notion of authenticity: credibility, complexity and ownership. For learners to feel that an environment offers credible opportunities for learning, especially when skill development is paramount, they need to be able to explore the behaviour of the systems, which are the focus of their learning. One way to do this is through working with simulations of the systems to be mastered. The environment should provide the learner with intrinsic feedback, which represents the effects of the learner's action on the system and mechanisms to experiment with ideas, try out different solutions to problems and reflect on those solutions.

Grabinger and Dunlap (1995) emphasise that learners should be presented with complex environments that represent interesting and motivating tasks, rather than contrived sterile problems. Only in complex, rich environments will learners have the opportunity to construct and reconstruct concepts in idiosyncratic and personally meaningful ways. However, learners may need help in coping with the skills to be developed in complex domains. Strategies, which have proved useful in helping learners, include scaffolding (Krajcik, Soloway, Bulmenfeld, & Marx, 1998), anchoring (Cognition and Technology Group at Vanderbilt, 1990) and problem-based environments (Grabinger, Dunlap, & Duffield, 1997; Tobin & Dawson, 1992). Representation of this type of scaffolding can be very effective if a broad range of multimedia resources can be used to support the context being examined.

### The Simulation Paradigm

Simulations as learning environments have had a long history of use in education and training and have been based on a variety of theoretical views of learning. Along with increasing computational power, software has increased in complexity so that object oriented systems can now be used to simulate devices of great complexity making use of extensive simulation of this complexity.

Initial claims for the educational benefits of using simulations tended to emphasise pragmatic solutions to classroom problems. Processes, which take a long, time, e.g., population growth or genetic change, or which happen very quickly, e.g., changes in impulsive force during a

collision are possibilities for simulation. Difficult, dangerous or expensive processes are also candidates for simulation, e.g., experiments with radioactive materials. The study of large-scale complex systems, such as the ecology of natural habitats or major industrial processes, also provides a rationale for simulation. Simulation can also be used to implement multiple perspectives where learners can either hypothesise or predict outcomes and then review interpretation from different views.

The key feature of an educational or training simulation is that it makes use of a model to represent a process, event or phenomenon, which has some learning significance. The learner is able to interact with this representation and the simulation provides intrinsic feedback that the learner can interpret as the basis for further interaction. The underlying model may be mathematical leading to the generation of numerical results, rule-based with the intention of providing feedback on subjective input, or even context-based in that the learner is placed in a context that simulates a real situation.

Bliss and Ogborn (1989) have described computer-based simulations as programs in which the computer acts as an exploratory tool, supporting a real world activity while facilitating user understanding of the processes involved in complex dynamic systems, which may otherwise be inaccessible. Essentially, educational simulations are experiential exercises. They are useful wherever real objects or processes are involved in a learning task — they are less dangerous, less messy, and, if well designed, can exactly model real world objects and processes. Simulations can not only display aggregated behaviour, illustrating the interactions of objects or processes, but they can also be decomposed into constituent elements which can be manipulated to simulate variation in systems.

Another view of a simulation is that they may be considered as 'a special kind of model representing a "real world" system, governed by a set of rules' (Crookall et al. 1987). This view is based on models that may be regarded as *black boxes*, with their form and structure hidden from the learner. If the model is hidden, learners are expected to believe in the credibility and authenticity of the model as an act of faith. The model may also be presented in an examinable form, thus allowing learners to observe how the model operates. In some cases it may even be possible to change the model or at least some of its parameters. A broader view of simulation can be taken if an "in context" environment is considered as a simulation. In this form, the simulation is designed to place users in a relevant context where they can investigate an issue and solve a problem without necessarily receiving the intrinsic feedback characteristic of the more mathematically or rule-based simulations.

While working with such models, the user often comes to see the simulation as a *real world* in its own right (Crookall et al. 1987). Such models can be considered as representing real-world systems as either an *in-place-of* or a *bring-to-life* format. Harper, Squires and McDougall (2000) have proposed that this type of model could be considered to be a hybrid simulation, which incorporates both symbolic and experiential representations, and have argued that good design within this simulation context would make extensive use of a rich array of multimedia resources.

Regardless of the type or format of the simulation, the overriding purpose for simulating systems remains to provide a learning environment that supports the learner to develop mental models about a process or the interrelationships of variables. Simulations can help

learners achieve these objectives by providing a substitute experience for those processes and systems, which by reason of cost, scale, time or risk would not normally be accessible. In the design reported here, the simulations allow learners to explore road safety issues, where extreme risk is involved, without being exposed to that risk.

### **The Project: Road Risks -Your Choice**

Road safety education has long been incorporated into syllabus documents within Australian education systems. The New South Wales Road and Traffic Authority (RTA) has funded a series of teaching resources to support the syllabus objectives. One such funded project, *Road Risks - Your Choice*, a suite of road safety resources that would provide the opportunity for young people to explore road safety issues, was guided by a number of outcomes as described in the syllabus document – *Personal Development Health and Physical Education (PDHPE), Years 7-10*. In relation to the area of road safety, it specifically asks students to identify 'the consequences of risk behaviours and describe(s) strategies to minimise harm' (Board of Studies, 2003, p.28). To achieve such an outcome, the syllabus asks that teachers define risk factors and behaviours in a range of road environments and situations, examine the relationship between them and describe strategies to minimise harm as a passenger, pedestrian, and user of wheeled devices.

An analysis of road crash data indicates that whilst a single factor may contribute to a crash occurring, in the majority of cases it is usually the combination of a number of factors that are the cause of a crash. Indeed, 95 per cent of motor vehicle crashes have human factors alone or in combination with one or more other factors as major contributors (Roads and Traffic Authority of NSW, 1996).

Potential risk factors from a road safety perspective can be broadly divided into:

**Human factors – the behaviour of any people involved.**

**Vehicle factors – Features of any vehicle involved, e.g., type, size, condition, safety equipment.**

**Environmental factors – Features of the road and the surrounding area e.g.: surface of the road, condition of the road, things near the side of the road like trees and poles.**

Recognising the interaction of such factors and the necessity for developing effective countermeasures to not only prevent crashes from occurring, as well as reduce injury and death should a crash occur, William Haddon designed a matrix, subsequently called the Haddon matrix (O'Neil, 2002). The Haddon matrix examined from a human, vehicle and environment perspective the:

**Pre-event phase: The various factors that play a role in determining whether potentially damaging crashes will actually take place.**

**Event phase: Period in which an energy exchange takes place and damage or injury occurs.**

**Post-event phase: Period after energy damage has already occurred; numerous factors**

influence the severity of damage to people and property during this time.

By completing the matrix, investigators were able to visualise the factors that contributed to a crash occurring along with the countermeasures to be put in place to reduce crash losses.

The Haddon matrix was therefore seen by the design team as providing both the theoretical framework for the development of the two major simulations and the structure necessary for school students to carry out an investigation of a potential crash scene and subsequently the development of harm minimising strategies that could then be applied to their particular travel circumstances. Recognising the complexity of such a matrix should all phases be examined, and the sensitivities involved in showing a crash actually occurring for 12-14 year old students, 'Risk PI' (Private Investigator) and 'What's your view?' were developed as simulations to represent an authentic context for learners where students examined the pre-event and event phases only.

### **Designing 'Risk PI' and 'What's your view?'**

In meeting the outcomes of the syllabus, the design team decided that two simulations should be developed that would highlight the complexity of the road environment. The first, 'Risk PI', would provide a selection of five road safety investigations (Passenger, Pedestrian, Safety on Wheels, Future Driver and The Whole Story). The framework would give students the opportunity to recognise and suggest strategies to be put into place from a human, vehicle and environment perspective and to develop plans to minimise harm associated with the situations described in the video scenes. They are then asked to reflect upon their simulated investigation and apply the strategies developed to their own personal situation or environment.

The second simulation, 'What's your view?', would also involve a number of investigations where human, vehicle and environmental factors were at play, in addition to each scenario demonstrating the complex relationships in the road environment between passengers, pedestrians, wheels users and drivers. Students were asked to investigate each scene from a number of road user perspectives, finally reflecting upon their simulated investigations and applying the strategies developed to their own personal situation or environment.

### **Formative Evaluation**

Given that this integrated resource is the first of its kind at a secondary level in NSW in attempting to bring together the road user groups that are of risk in the age group 12-14, and that there is a strong emphasis on the use of technology for students, this resource represents a significant shift in the use of information and communication technology (ICT) to enhance teaching and learning in the key learning area of PDHPE. To ensure that the two ICT simulation activities were indeed able to result in students achieving the outcomes as intended within the syllabus, formative evaluations of the prototypes were carried out on two occasions during 2003.

Teachers were approached from across the NSW Department of Education and Training, Catholic Education Commission-NSW and the Association of Independent Schools of NSW from schools reflecting urban, regional and rural areas, all boy, all girl and co-educational schools. The number of schools from each sector was weighted to reflect their proportion of the whole

school population. In total, 44 teachers were utilised with each asked to trial between 1-2 activities with their Year 7 and 8 PDHPE classes. 'Risk PI' and 'What's your view?' were trialled in 11 schools with 1-2 classes in each school utilising the prototypes. Nominated Year 7 & 8 PDHPE teachers used early prototypes of each component of the resource in class and provided feedback on a range of criteria associated with the model of pedagogy endorsed within the NSW Department of Education and Training, the 'Quality Teaching Framework' (DET, 2003). Teachers' were asked to comment on the:

appropriateness of the contexts for young people as passengers, pedestrian, wheels or future drivers and the various social and cultural contexts provided within the activities. Links made to student's backgrounds and personal experiences.

degree of learner engagement in the specific problem posed.

amount of instructions and feedback given on their responses on an on-going basis and on conclusion of the activity.

opportunity for teachers to utilise a range of teaching strategies.

opportunity for sustained interactions between students and also between students and teachers.

The findings as presented in Table 1 highlight the most pertinent observations at each trial conducted. Given that not all teachers commented on all of the criteria, an analysis of the comments indicates that overall there were major improvements in all facets of the resource between July and November. Given the timing of the trials in the development process (particularly the July trial) it was typical that the activities contained key functionality but suffered from artwork still under development and in some cases content still undergoing review. When considering the feedback data the project team needed to keep this in mind looking for deeper issues needing rectification as well as using the comments about style and content to confirm or modify our development direction.

The July comments were analysed and acted upon where appropriate, leading to the high degree of satisfaction with the various components of the resource in November. This was reflected particularly in the language utilised to describe the criteria as discussed above.

**Table 1 – Emergent themes from July and November trials**

Criteria	Month	Risk PI	What's your view
Overall comments	July	?1 As a whole the resource lacks the 'wow' factor  ?2 Tasks need to be made more explicit	?3 Potentially an excellent resource but needs work

	Nov	<p>?4 Very effective with the opportunity for great flexibility</p> <p>?5 Huge improvement- well set out</p> <p>?6 Easy to generate responses and create discussion</p>	<p>?7 Very effective teaching resource</p> <p>?8 Very enjoyable activity for students and teachers</p>
Appropriateness	July	<p>?9 Wording too complicated in places</p> <p>?10 Supported the syllabus outcomes</p>	<p>?11 Answers are too easy and obvious</p> <p>?12 Literacy levels are fine</p> <p>?13 Supported the syllabus outcomes</p>
	Nov	<p>?14 Literacy level was appropriate for students</p> <p>?15 Realistic and believable characters for the age group</p>	<p>?16 Questions are just right</p> <p>?17 Literacy is not a problem</p> <p>?18 Good variety of questions</p>
Learner engagement	July	<p>?19 Students engaged and enjoyed the task</p> <p>?20 Assisted students to develop critical thinking skills</p> <p>?21 The activities encouraged students to relate their own road safety experiences</p>	<p>?22 Graphics do not engage the students</p> <p>?23 Lacks challenge</p> <p>?24 Excited – but disappointed with the questions</p> <p>?25 Need to have more close-ups of characters with more detail</p>
	Nov	?26 Students	



		<p>thought about road safety from different road user points of view</p> <p>?27 Students were able to transfer skills to other health issues eg drug education</p> <p>?28 Activities were interactive and students worked at their own pace</p>	<p>?29 " Really cool "</p>
Instructions and feedback	July	<p>?30 More instructions needed on how to use the activity and navigate –tasks to be more explicit and terms defined</p> <p>?31 A report template required for students to write up their work after the activity</p> <p>?32 Model correct responses</p>	<p>?33 Need for ongoing scores and feedback on incorrect and correct responses</p> <p>?34 More instructions needed on how to use the activity and navigate</p> <p>?35 Questions cover the screen</p>
	Nov	<p>?36 Opening screen instructions made it easy to understand and work through</p> <p>?37 Hints encouraged appropriate responses</p>	<p>?38 Opening screen instructions gave overview of how to use the activity - made it easy to understand and work through</p> <p>?39 Good to see feedback as to correct or incorrect answers.</p>
Teaching strategies	July	<p>?40 Sufficient information for</p>	<p>?43 Structure of tasks allowed only for</p>

		<p>teachers</p> <p>?41 Teaching strategies appropriate for a range of groups</p> <p>?42 Provide additional options for use with activities</p>	<p>teacher directed approaches.</p> <p>?44 Need for more flexibility to make more student directed</p>
	Nov	<p>?45 Additional extension activities were great options</p> <p>?46 Plenty of information for teachers</p> <p>?47 Provided the ability for students to direct own learning</p>	<p>?48 Teachers provided with the flexibility for a variety of teaching strategies to be used with classes.</p>
Interaction	July	<p>?49 Provoked significant discussion between students</p> <p>?50 Promoted much discussion with the teacher.</p>	<p>?51 No interaction between students or teachers as answers are too easy</p>
	Nov	<p>?52 Provoked positive discussion between students and with the teacher.</p>	<p>?53 Questions posed during the activity and in the review activity created discussion both within student groups and the teacher</p>

### Emergent themes and design modifications

**Providing an overarching set of guidelines for the project was that students within NSW secondary schools, Years 7 & 8 (12-14 years of age) would be provided with stimulating and relevant activities that would involve them in meaningful learning experiences. All activities**

would employ active and engaging learning strategies and be designed to be flexible and easily modified to meet the needs of different learners and teaching styles.

As a result of the range of consultative and trialling processes conducted over a period of 12 months, a number of major themes emerged that guided the practical implementation of these principles within the development of the two CD-ROM simulations.

**More engaging graphics, sound effects and animations**

**An enhanced ability for activities to be used flexibly by students and teachers**

**More feedback on student responses given, both during and at the completion of the activities**

**The ability of students to relate the key messages to their real life circumstances**

**The ability of students to save and print their work for further consideration in classroom discussions**

To demonstrate how modifications were made to the prototypes based on the major themes to emerge from the trials, examples from 'What's your view?' and 'Risk PI' are highlighted below.

Figure 1 represents the earliest trial version of 'What's your view?' (WYV) and provides a comparison for changes made in Figures 2 & 3 that are examples from the final product.

In this early version:

?1 The road environment depicted lacks the complexity of a real road environment. Colours are unsaturated, and the image generally lacked contrast and a sense of depth. This leaned towards a sterile, flat feeling to the image.

?2 The progression between scenes is linear with no opportunity for users to be flexible in choosing scenes to

Figure 1:

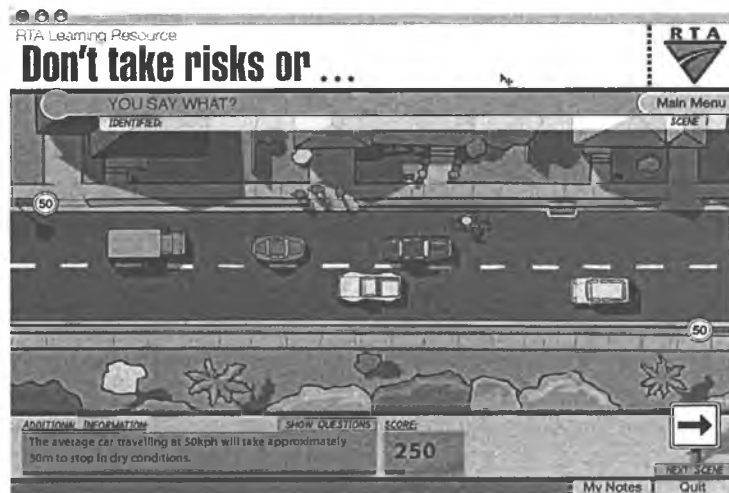


Figure 2: Final version



examine

?3 There is no 'Activity review' that provides an overview of the whole activity and opportunity for students to relate what they have learnt to their real life situations.

?4 Additional road safety information is isolated from the situation that it is relevant to.

In *Figure 2*, 'What's your view?' was modified to:

- 1 make the road environment more sophisticated with more detail to the road environment (eg. road signs, driveways, supermarkets, vehicle types).

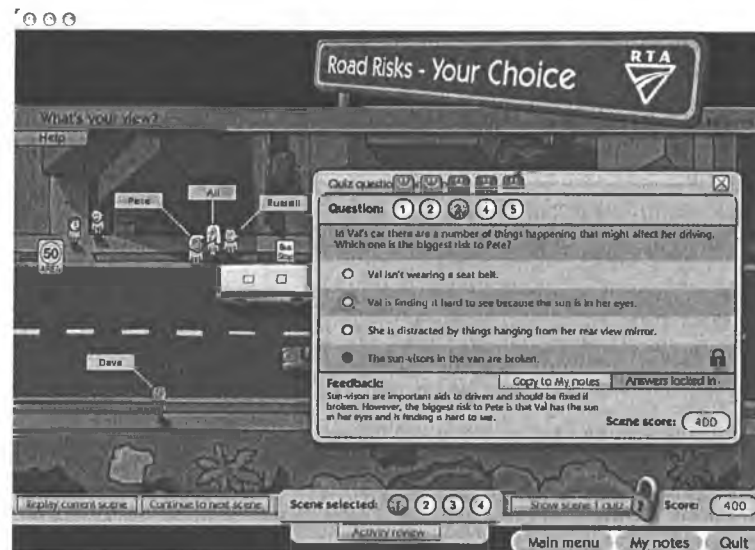
- 2 reflect a contemporary feel. More saturated colours and higher contrast was used to produce a "grungy, more textured" appearance that appeals to young users.

?3 appeal to younger learners, with a pseudo-3D feel introduced to the backgrounds, characters and vehicles changing from a top down view i.e. "the head on a stick approach", to more cartoon-like characters.

?4 enhance learner engagement with the road users assigned names along with the ability of the learner to "zoom in" on characters. Road safety knowledge was also embedded and aligned with specific road safety situations.



*Figure 3: Final version*



?5 increase the flexibility of use for students and teachers by replacing the linear navigation from Fig 1. Users are able to start at any scene, as well as replay the current scene or follow a linear progression.

*Figure 3* demonstrates the changes made to WYV, to enhance feedback for students.

·1 To provide ongoing feedback, at the end of each scene (after answering five questions) students were able to view their score and gain feedback on the answers given rather than waiting until the end of the whole activity. In the example shown, the student has answered incorrectly, and is shown their answer as well as the correct answer along with an explanation as to why their answer was incorrect.

?2 The addition of an 'Activity review' option that could only be accessed once all scene quizzes were complete was included to ensure students had explored all scenes. After answering all the questions they are able to apply the results of their investigations to road user situations that they may find themselves in.

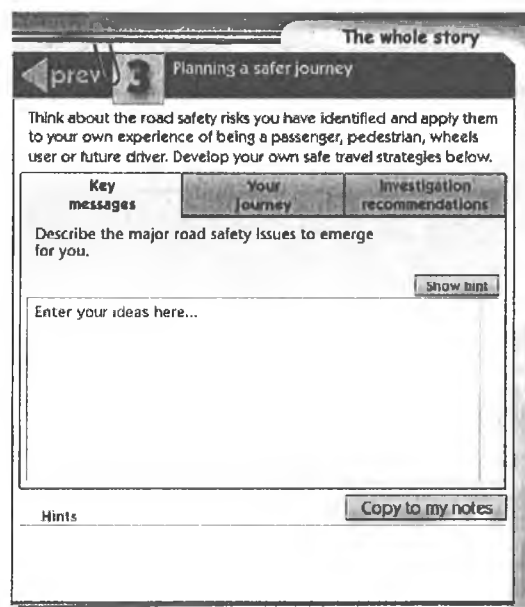
**The 'Risk PI' example below demonstrates the changes made to the concluding activity from an investigation utilising the video, *The whole story* that was developed to cover all road safety areas; wheels users, pedestrian, passengers and young drivers. In the earliest reviewed version, students were asked to describe in an unstructured approach, how the things they had learnt from their investigations could be used to minimise harm in road safety situations**

generally (see Figure 4). The designer's intention was that teachers would ask students to complete *The whole story* only after they had completed at least two of the other available investigations, which were more highly structured. It was expected that some students would benefit from an opportunity encouraging them to think at a deeper level by applying the Haddon matrix framework learnt in earlier investigations.

Figure 4: Early trial



Figure 5: Modified interface



As a result of the first trial however, respondents indicated that *The whole story* be modified in two ways (see Figure 5).

Utilise the framework in each of the other investigations to enable the activity to allow 'Risk PI' to be used more flexibly. For example, should a teacher wish to only use *The whole story* because of time constraints, the framework would exist for students to complete the task and not be dependent on having completed other investigations beforehand.

Rather than leaving the final task open-ended and not related to any specific real life situation, they are directed to relate what they have learnt to a specific journey that they take as a road user, from either a passenger, pedestrian, wheels user or future driver perspective.

As evidenced by the examples described above, there was a considerable merit in gaining feedback on the prototypes from a variety of sources over various time periods before too much design time was allocated to them, as well as in confirming the direction of changes already in train in the resource production such as, the addition of sound effects (already under development but not implemented in the early trial), initial instructions which modelled how to use the activity (which could not be efficiently developed and implemented until all content and artwork was final), hints to help in the completion of tasks (being finalised alongside media content), additional navigational tools, flexibility options and feedback mechanisms.

Whilst it would appear that there are a number of advantages of an early start to the review process, there are some points of compromise that occur. In a product that contains a large amount of artwork that evolves as the interface and style are refined, the visual experience early testers would receive is likely to be far inferior to using the finished product. At points of early testing there are also likely to be areas of complex functionality that are still under development. The range of comments received from early testing indicated that some testers were able to look at the underlying instructional value and process of the activity and provide useful commentary on the design. Other testers were more distracted by the 'unpolished' nature of the material and provided comments that were of interest but more than likely already flagged for modification as part of the normal development process.

Such issues need to be carefully considered and negotiated so that a sensible balance is developed between the ongoing sequential development of the project and the need to fast-track technical solutions to ensure stability of the resource in a distributed testing environment using end-users.

### **Conclusions and Research Agenda**

The complete suite of resources is currently being introduced into all schools in the state of New South Wales (NSW) during 2004-2005. Schools are not able to access the resource until Road Safety Consultants from both public and private school systems provide professional development workshops for teachers as they integrate the resource into their school programs. Workshops have begun across all the education sectors. Already, initial data from the trialling of the resource throughout 2004 indicates that the resource is well received by experienced secondary school physical and health education teachers who are in the main responsible for its implementation within the Personal Development, Health and Physical Education key learning area. In the main the survey results are overwhelmingly supportive of the range of resources, the ability of each of the activities to satisfy syllabus requirements and the depth and quality of information required to conduct lessons utilising the teaching notes that have been developed.

Within the NSW Department of Education, a series of workshops involving over 450 participants have been conducted. At the completion of the workshop where the RRYC resource was introduced and explained, participants were asked their perceptions of how useful each of the components (print, video and CD-ROM) will be in the teaching of road safety education at their school. Participants were asked to rank the components from 1 (not very useful) to 4 (very useful). For all components, the overwhelming majority of participants ranked each of the components a 4 (very useful). Less than 5 per cent of respondents in each resource category described the components as not very useful. With regard to the CD-ROM activities specifically, which included Risk PI and What's your view, the overwhelming majority of participants (93%) rated the activities as useful to very useful.

Given the overwhelming support from teachers for the teaching resource, the design group therefore is interested in investigating how the use of simulations on CD-ROM contributes to students understanding of the factors that contribute to crashes and the complexity of the road environment. As schools are only just starting to implement the resource after their initial training in its implementation, a research plan is currently being developed to investigate the use of the project in a variety of class settings, in particular the understandings of the various

factors that interact and contribute to potential harm in road safety contexts and student's abilities to identify these factors in various road use settings. It is hoped the use of an experiential simulation, supported by rich multimedia resources, in an authentic context will result in clear learning outcomes and increase the success of road safety education in New South Wales schools.

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